

WHAT IS CLAIMED IS:

1. A slippage prevention apparatus of a belt-drive continuously variable transmission for an automotive vehicle, which employs a primary variable-width pulley of an input side, a secondary variable-width pulley of an output side, and a drive belt running in the primary and secondary pulleys, and whose downshift is made by an increase in a V-groove width of the primary pulley arising from a drop in a primary pulley pressure supplied to the primary pulley and a decrease in the V-groove width of the secondary pulley occurring in synchronism with the drop in the primary pulley pressure, or by a decrease in a V-groove width of the secondary pulley arising from a rise in a secondary pulley pressure supplied to the secondary pulley and an increase in the V-groove width of the primary pulley occurring in synchronism with the rise in the secondary pulley pressure, comprising:

a belt slippage foretelling section that foretells that a slippage between the drive belt and each of the primary and secondary pulleys tends to occur when the primary pulley pressure is dropping; and

a primary-pulley-pressure drop inhibition section that inhibits the primary pulley pressure from dropping, when the belt slippage foretelling section foretells that the slippage between the drive belt and each of the primary and secondary pulleys tends to occur.

2. The slippage prevention apparatus as claimed in claim 1, wherein:

the belt slippage foretelling section foretells that the slippage between the drive belt and each of the primary

and secondary pulleys tends to occur, when the primary pulley pressure is less than a first predetermined pressure level and a primary pulley speed is less than a first predetermined rotational speed.

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3. The slippage prevention apparatus as claimed in claim 2, wherein:

the belt slippage foretelling section determines that there is a less possibility for the slippage between the drive belt and each of the primary and secondary pulleys to occur, when the primary pulley pressure is higher than or equal to a second predetermined pressure level higher than the first predetermined pressure level, or when the primary pulley speed is greater than or equal to a second predetermined rotational speed higher than the first predetermined rotational speed.

4. The slippage prevention apparatus as claimed in claim 1, wherein:

the belt slippage foretelling section foretells that the slippage between the drive belt and each of the primary and secondary pulleys tends to occur, when the primary pulley pressure is less than a first predetermined pressure level.

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5. The slippage prevention apparatus as claimed in claim 1, wherein:

the belt slippage foretelling section foretells that the slippage between the drive belt and each of the primary and secondary pulleys tends to occur, when the primary pulley pressure is less than a first predetermined

pressure level and a vehicle speed is less than a predetermined vehicle-speed threshold value.

6. The slippage prevention apparatus as claimed in claim
5 1, wherein:

the belt slippage foretelling section foretells that the slippage between the drive belt and each of the primary and secondary pulleys tends to occur, when the primary pulley pressure is less than a first predetermined
10 pressure level, and a vehicle speed is less than a predetermined vehicle-speed threshold value, and a primary pulley speed is less than a first predetermined rotational speed.

15 7. The slippage prevention apparatus as claimed in claim 2, wherein:

the first predetermined pressure level for the primary pulley pressure is set to a pressure level lower than a required primary pulley pressure, which is
20 determined based on an actual transmission ratio and a transmission input torque, by a predetermined pressure.

8. The slippage prevention apparatus as claimed in claim 1, wherein:

25 the belt slippage foretelling section foretells that the slippage between the drive belt and each of the primary and secondary pulleys tends to occur, when a vehicle's deceleration rate is greater than or equal to a predetermined deceleration rate.

9. The slippage prevention apparatus as claimed in claim 1, wherein:
the belt slippage foretelling section foretells that the slippage between the drive belt and each of the primary and secondary pulleys tends to occur, when a vehicle's deceleration rate is greater than or equal to a predetermined deceleration rate and a vehicle speed is less than a predetermined vehicle-speed threshold value.
10. The slippage prevention apparatus as claimed in claim 1, wherein:
the belt slippage foretelling section foretells that the slippage between the drive belt and each of the primary and secondary pulleys tends to occur, when a vehicle's deceleration rate is greater than or equal to a predetermined deceleration rate and a primary pulley speed is less than a first predetermined rotational speed.
11. The slippage prevention apparatus as claimed in claim 1, wherein:
the belt slippage foretelling section foretells that the slippage between the drive belt and each of the primary and secondary pulleys tends to occur, when a vehicle's deceleration rate is greater than or equal to a predetermined deceleration rate, and a vehicle speed is less than a predetermined vehicle-speed threshold value, and a primary pulley speed is less than a first predetermined rotational speed.
12. The slippage prevention apparatus as claimed in claim 1, wherein:

the primary-pulley-pressure drop inhibition section sets an actual transmission ratio, which is calculated before a set time period from a time when the slippage between the drive belt and each of the primary and secondary pulleys has been foretold, to a desired transmission ratio, and outputs a command signal corresponding to the desired transmission ratio to a ratio-change control actuator.

10 13. The slippage prevention apparatus as claimed in claim 12, wherein:

the primary-pulley-pressure drop inhibition section returns the ratio-change control actuator to an operative position obtained before the set time period from the time when the slippage between the drive belt and each of the primary and secondary pulleys has been foretold.

20 14. The slippage prevention apparatus as claimed in claim 1, wherein:

the primary-pulley-pressure drop inhibition section holds a ratio-change operating state obtained when the slippage between the drive belt and each of the primary and secondary pulleys has been foretold.

25 15. The slippage prevention apparatus as claimed in claim 1, wherein:

the primary-pulley-pressure drop inhibition section sets a transmission ratio of a relatively higher speed side as compared with a ratio-change operating state obtained when the slippage between the drive belt and

each of the primary and secondary pulleys has been foretold,
to a desired transmission ratio, and outputs a command
signal corresponding to the desired transmission ratio
set to the transmission ratio of the relatively higher
5 speed side to a ratio-change control actuator.

16. The slippage prevention apparatus as claimed in claim
15, wherein:

the primary-pulley-pressure drop inhibition
10 section sets a predetermined maximum pulley ratio to the
desired transmission ratio, and outputs a command signal
corresponding to the desired transmission ratio set to
the predetermined maximum pulley ratio to the ratio-change
control actuator.

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17. The slippage prevention apparatus as claimed in claim
1, wherein:

the primary-pulley-pressure drop inhibition
section relatively rises a line pressure, which is used
20 as an initial pressure for the primary pulley pressure,
as compared with a line pressure level produced when the
slippage between the drive belt and each of the primary
and secondary pulleys has been foretold.

25 18. A method of preventing a slippage between each of
a primary variable-width pulley of an input side and a
secondary variable-width pulley of an output side and
a drive belt running in the primary and secondary pulleys,
all employed in a belt-drive continuously variable
30 transmission for an automotive vehicle whose downshift
is made by an increase in a V-groove width of the primary

pulley arising from a drop in a primary pulley pressure supplied to the primary pulley and a decrease in the V-groove width of the secondary pulley occurring in synchronism with the drop in the primary pulley pressure,
5 or by a decrease in a V-groove width of the secondary pulley arising from a rise in a secondary pulley pressure supplied to the secondary pulley and an increase in the V-groove width of the primary pulley occurring in synchronism with the rise in the secondary pulley pressure,
10 the method comprising:

foretelling that the slippage between the drive belt and each of the primary and secondary pulleys tends to occur when the primary pulley pressure is dropping; and
inhibiting the primary pulley pressure from dropping,
15 when the slippage between the drive belt and each of the primary and secondary pulleys has been foretold.

19. The method as claimed in claim 18, further comprising:

20 foretelling that the slippage between the drive belt and each of the primary and secondary pulleys tends to occur, when a condition that the primary pulley pressure is less than a first predetermined pressure level is satisfied or when a combined condition of (i) the condition
25 that the primary pulley pressure is less than the first predetermined pressure level and (ii) at least one of a condition that a primary pulley speed is less than a first predetermined rotational speed and a condition that a vehicle speed is less than a predetermined vehicle-speed
30 threshold value is satisfied.

20. The method as claimed in claim 19, further comprising:

foretelling that there is a less possibility for the slippage between the drive belt and each of the primary and secondary pulleys to occur, when the primary pulley pressure is higher than or equal to a second predetermined pressure level higher than the first predetermined pressure level, or when the primary pulley speed is greater than or equal to a second predetermined rotational speed higher than the first predetermined rotational speed.

21. The method as claimed in claim 19, further comprising:

setting the first predetermined pressure level for the primary pulley pressure to a pressure level lower than a required primary pulley pressure, which is determined based on an actual transmission ratio and a transmission input torque, by a predetermined pressure.

22. The method as claimed in claim 18, further comprising:

foretelling that the slippage between the drive belt and each of the primary and secondary pulleys tends to occur, when a condition that a vehicle's deceleration rate is greater than or equal to a predetermined deceleration rate is satisfied or when a combined condition of (i) the condition that a vehicle's deceleration rate is greater than or equal to a predetermined deceleration rate and (ii) at least one of a condition that a primary pulley speed is less than a predetermined rotational speed and a third condition

that a vehicle speed is less than a predetermined vehicle-speed threshold value is satisfied.

23. The method as claimed in claim 18, further
5 comprising:

setting an actual transmission ratio, which is calculated before a set time period from a time when the slippage between the drive belt and each of the primary and secondary pulleys has been foretold, to a desired
10 transmission ratio; and

outputting a command signal corresponding to the desired transmission ratio to a ratio-change control actuator.

15 24. The method as claimed in claim 23, further comprising:

returning the ratio-change control actuator to an operative position obtained before the set time period from the time when the slippage between the drive belt
20 and each of the primary and secondary pulleys has been foretold.

25. The method as claimed in claim 18, further comprising:

25 holding a ratio-change operating state obtained when the slippage between the drive belt and each of the primary and secondary pulleys has been foretold.

26. The method as claimed in claim 18, further
30 comprising:

setting a transmission ratio of a relatively higher speed side as compared with a ratio-change operating state obtained when the slippage between the drive belt and each of the primary and secondary pulleys has been foretold,
5 to a desired transmission ratio; and

outputting a command signal corresponding to the desired transmission ratio set to the transmission ratio of the relatively higher speed side to a ratio-change control actuator.

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27. The method as claimed in claim 26, further comprising:

setting a predetermined maximum pulley ratio to the desired transmission ratio; and

15 outputting a command signal corresponding to the desired transmission ratio set to the predetermined maximum pulley ratio to the ratio-change control actuator.

28. The method as claimed in claim 18, further comprising:

20 relatively rising a line pressure, which is used as an initial pressure for the primary pulley pressure, as compared with a line pressure level produced when the slippage between the drive belt and each of the primary
25 and secondary pulleys has been foretold.